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THE EFFECT OF FLUOROCARBON SURFACTANT ADDITIVES ON THE  
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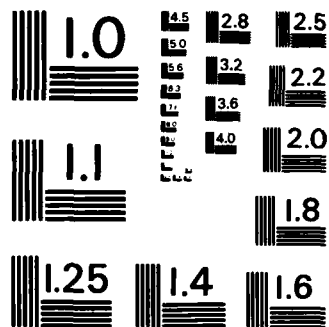
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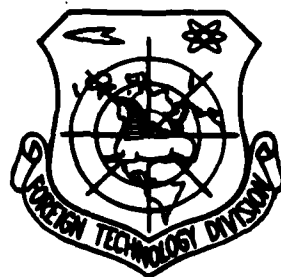


THE EFFECT OF FLUOROCARBON SURFACTANT ADDITIVES ON THE EFFECTIVE VISCOSITY  
OF ACETONE SOLUTIONS OF CELLULOSE DIACETATE

by

L.A. Shits, N. Yu. Kal'nova

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By: L.A. Shits, N. Yu. Kal'nova

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PREPARED BY:

TRANSLATION DIVISION  
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# U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

| Block | Italic     | Transliteration | Block | Italic     | Transliteration |
|-------|------------|-----------------|-------|------------|-----------------|
| А а   | <i>А а</i> | A, a            | Р р   | <i>Р р</i> | R, r            |
| Б б   | <i>Б б</i> | B, b            | С с   | <i>С с</i> | S, s            |
| В в   | <i>В в</i> | V, v            | Т т   | <i>Т т</i> | T, t            |
| Г г   | <i>Г г</i> | G, g            | У у   | <i>У у</i> | U, u            |
| Д д   | <i>Д д</i> | D, d            | Ф ф   | <i>Ф ф</i> | F, f            |
| Е е   | <i>Е е</i> | Ye, ye; E, e*   | Х х   | <i>Х х</i> | Kh, kh          |
| Ж ж   | <i>Ж ж</i> | Zh, zh          | Ц ц   | <i>Ц ц</i> | Ts, ts          |
| З з   | <i>З з</i> | Z, z            | Ч ч   | <i>Ч ч</i> | Ch, ch          |
| И и   | <i>И и</i> | I, i            | Ш ш   | <i>Ш ш</i> | Sh, sh          |
| Й й   | <i>Й й</i> | Y, y            | Щ щ   | <i>Щ щ</i> | Shch, shch      |
| К к   | <i>К к</i> | K, k            | Ъ ъ   | <i>Ъ ъ</i> | "               |
| Л л   | <i>Л л</i> | L, l            | Ы ы   | <i>Ы ы</i> | Y, y            |
| М м   | <i>М м</i> | M, m            | Ь ь   | <i>Ь ь</i> | '               |
| Н н   | <i>Н н</i> | N, n            | Э э   | <i>Э э</i> | E, e            |
| О о   | <i>О о</i> | O, o            | Ю ю   | <i>Ю ю</i> | Yu, yu          |
| П п   | <i>П п</i> | P, p            | Я я   | <i>Я я</i> | Ya, ya          |

\*ye initially, after vowels, and after ъ, ь; e elsewhere.  
When written as ë in Russian, transliterate as yë or ë.

## RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

| Russian | English | Russian | English | Russian  | English            |
|---------|---------|---------|---------|----------|--------------------|
| sin     | sin     | sh      | sinh    | arc sh   | sinh <sup>-1</sup> |
| cos     | cos     | ch      | cosh    | arc ch   | cosh <sup>-1</sup> |
| tg      | tan     | th      | tanh    | arc th   | tanh <sup>-1</sup> |
| ctg     | cot     | cth     | coth    | arc cth  | coth <sup>-1</sup> |
| sec     | sec     | sch     | sech    | arc sch  | sech <sup>-1</sup> |
| cosec   | csc     | csch    | csch    | arc csch | csch <sup>-1</sup> |

Russian English

rot curl  
lg log

## GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

## THE EFFECT OF FLUOROCARBON SURFACTANT ADDITIVES ON THE EFFECTIVE VISCOSITY OF ACETONE SOLUTIONS OF CELLULOSE DIACETATE

L. A. Shits, N. Yu. Kal'nova (Institute of Physical Chemistry of the AS USSR, Moscow)

→ The fact that the viscosity of acetone solutions of cellulose diacetate (CDA) [DATs] can be reduced by the addition of small quantities of water has been known for a long time [1]. It is given practical application in the production of acetone fiber [2]. An analogous viscosity reduction effect is achieved when water or butanol (about 3% by volume) is added to acetone solutions of partially saponified polyvinyl acetate [3]. The literature contains recommendations on the introduction of CDA together with aqueous semi-colloidal surfactants (PAV) of the alkylbenzol sulfonate type into acetone solutions [4].

✕ In our study, using Na salts of perfluoroenanthic (perfluorogentylol) acid we showed that it was possible to reduce the effect of viscosity in CDA solutions in acetone by introducing small quantities of highly surface-active fluorocarbon substances (fluorothenzides) in the presence of water. In the experiment CDA with a molecular mass of about 28,000 was used. Viscosity measurements ( $\eta$ ) were taken in centipoise using a "Rheotest RV" rotation viscosimeter at different shear stresses ( $\tau$ ) in a range of 150-4000 dynes/cm<sup>2</sup>. Prior to viscosity measurement the solution specimens were held in a thermostat for two days.

Curves  $\lg \eta(\lg \tau)$  for 9% solutions of CDA in acetone with different concentrations of water (up to 8% of the volume of the solvent) at 30°C are shown in Fig. 1. The dependence of  $\eta$  on the concentration of water in the solvent is given for  $\tau = 500$  dynes/cm<sup>2</sup>; this is the range of  $\tau$  values in which the viscosity depends on shear stress to the least degree. The  $\eta$  value minimum in the studied solutions falls within a water content of about 1%.

Sodium salt of perfluoroenthanic acid in quantities of up to 1% by weight of the polymer was introduced in a dissolved form into 9% solutions of CDA containing 0.3, 0.9, and 1.8 % by volume of water. The change in viscosity of these solution as a function of the fluorothenzide is shown in Fig. 23 (curves 1, 2 and 3). Also shown here is curve 4 for a 20% solution of CDA containing about 1% water.

In Fig. 2 viscosity is presented in relative units, i.e., values  $\eta'$  are determined by the ratio of the viscosity of the studied solution to the viscosity of CDA of the same concentration but without the additives. When, instead of the salt of perfluoroenthanic acid, we used a standard type of surfactant (sodium dodecylbenzosulfonate, sodium dialkylsulfosuccinate, polyglycol esters of alkylphenols) in the same quantities and under the same experimental conditions, no decrease in the viscosity of the solutions was observed, and, in a number of experiments, a pronounced increase in viscosity was recorded.

Thus, the effect of reducing viscosity in CDA solutions under the influence of small concentrations of surfactants (tenths of % in relation to the weight of the polymer) is observed only in the case of fluorothenzide. The effect of the reduction in viscosity with a concentration of the polymer depends on the concentration of the non-solvent (water) in the solvent (acetone) and passes through the maximum, where the fluorothenzide, as the agent which reduces viscosity, is most effective when the concentration of water is one which assures a minimal  $\eta$  value under conditions where surfactants are present in the system. The minimum on the curve representing viscosity versus the concentration of fluorothenzide with an increase in the concentration of water, shifts to the range of high thenzide concentrations.

As the concentration of the polymer decreases (with the concentration of water remaining constant) the effect of viscosity reduction in CDA solutions under the effect of fluorothenzide decreases.

The obtained results can be interpreted as follows. As the nonsolvent in the system is increased, the kinetic unit - one macromolecule or an associate of the group of macromolecules - becomes more compact, combines a smaller quantity of the dissolving medium, and changes its hydrodynamic characteristics toward a decrease in the viscosity of the solution. At the same time the intermolecular (or interassociate) relationship increases. With an increase in the concentration of the nonsolvent the first tendency approaches a certain limit, while the second intensifies, arriving at a progressive growth in the structural component of viscosity. Thus arises the minimum on the curve representing viscosity versus the concentration of water in the solution (see Fig. 1). When between the structural elements of the solution with increased density ("kinetic units") sufficiently strong cohesion no longer exists (the concentration of water is below 1%), the introduction of fluorothenzide leads to their screening and a weakening of the interaction. This occurs because of the low molar cohesion of the fluorocarbon molecules, which, may be concentrated around structural elements of increased density. With an increase in the density and cohesion strength of the structural elements (water concentration above 1%) the screening effect of the fluorothenzide becomes less effective.



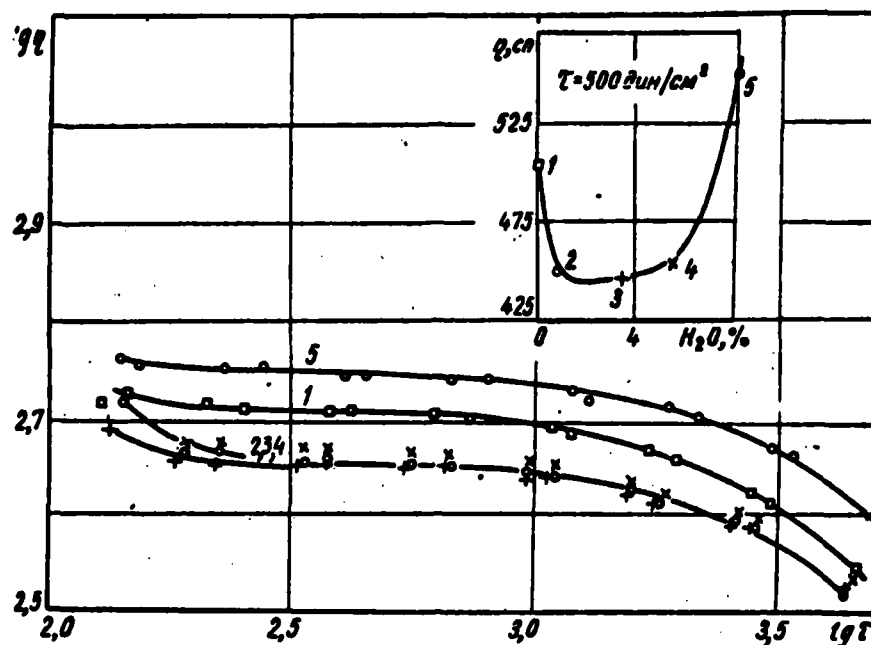


Fig. 1. Viscosity of .9% solutions of cellulose diacetate on the concentration of water in water-acetone mixture (vol. %): 1 - 0, 2 - 0.9, 3 - 3.6, 4 - 4.5, 5 - 8.1.

KEY: (1) Dynes/cm<sup>2</sup>.

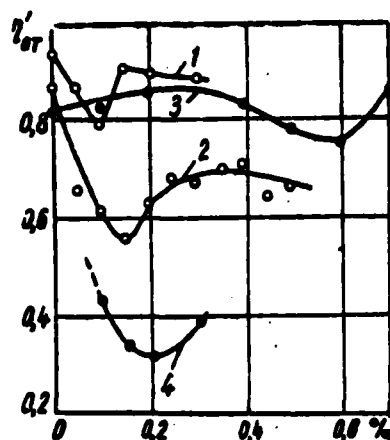


Fig. 2. Viscosity of cellulose diacetate solutions as a function of the concentration of Na-salt of perfluoroenthanic acid [in % to weight of polymer]: 1-3 - .9% solutions of CDA containing 0.3, 0.9, and 1.8 vol. % water respectively ( $\tau = 500$  dynes/cm<sup>2</sup>); 4 - 20% solution CDA containing 0.9 vol. % water ( $\tau = 1500$  dynes/cm<sup>2</sup>).

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